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Subject: AASRT final report (AFOSR-95-0368)

This AASRT grant was to support the Ph.D. work of Tom Spirock who is a native of New Jersey. Tom will finish his Ph.D. this year, thanks in large part to AASRT support. His work was to build an infrared magnetograph and use it for scientific work.

The Science:

Solar magnetic fields are concentrated in flux tubes, and appear on different scales: sunspots, pores (small sunspots without penumbra) and magnetic network flux elements. The magnetic network elements are the detritus of decaying active regions and play an important part in the solar cycle. They are very long lived.

Study of the physical mechanism underlying small scale magnetic flux tubes and their associated bright faculae in the magnetic network has attracted increased attention, since it is now clear that faculae seem to provide the main contribution to the observed changes in the solar irradiance over the 11 year solar activity cycle. The center-to-limb variation of the contrast of faculae provides tests of competing flux-tube models. The hot wall flux-tube model treated a facula as a tiny sunspot with kilogauss field strength and 100 km diameter (which is under the resolution of all ground-based observations). At disk center, it is darker inside a flux tube than the surrounding photosphere at the same physical height because the magnetic field suppresses convection. However, because the opacity inside the tube is lower, effectively a deeper layer (higher temperature) is observed. Those two effects cancel each other and make faculae have no net contrast at disk center. When the target is close to the limb, a large section of the "hot wall" is seen which increases the contrast. Finally, at the extreme limb the hot wall is no longer visible due to the fact that one side of the wall blocks the other side. On the other hand, the "hot cloud" model just assumes that the faculae are due to magnetic heating at or above the photosphere. It predicts

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that facular contrasts increase monotonically towards the limb, due to increased opacity. The "hillock" model assumes faculae are emission of heat which are flowing around sunspots. According to this model, the curve of facular contrast variation is between that of hot wall and hot cloud model--contrasts fall off only at very extreme limb.

Observations of facular contrasts in the near infrared (IR) are particularly interesting, because the opacity minimum is at 1.6 microns, so that we can probe deepest into the photosphere at that wavelength--adding additional constraints to the above models. Foukal and his colleagues have published a series of papers based on observations at that wavelength, and reported that many faculae are dark at disk center. This discovery would exclude the "hot clouds" and "hillock" models, since they would not explain the dark contrasts.

Tom Spirock set up NJIT's PtSi/Si camera at BBSO to observe contrasts of faculae at 1.6 microns. Our observations had several important advantages over those of Foukal et al.: (1) high quality of IR images because the camera has 320 by 240 pixels, and was carefully "home-made" by experts at NJIT.

(2) We have near-simultaneous high resolution observations of CaK, magnetogram and white-light with IR observations.

(3) We followed an active region from east to west limb.

(4) BBSO has better seeing conditions than Kitt Peak. We confirm several of Foukal et al.'s earlier results but could not confirm one of their results with respect to the comparison between IR and visible facular contrasts. We argue their conclusions about eliminating certain models is incorrect.

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